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ABSTRACT

The curriculum materials contained in this document were developed through a cooperative effort by educators in the state of Maryland. It was a curriculum project aimed at the meaningful integration of mathematics and science. It is suggested that these materials be used in two significant ways. First, this document can serve as an instructional materials resource collection. An extensive variety of technology topics are covered, with each topic including detailed information sheets identifying the mathematical and scientific principles that could be studied in a technology education activity. Secondly, this document can serve as a materials resource guide. This is accomplished by providing a format and process for the creation of similar classroom instruction materials. Topics include: (1) Bell XP-59A Airacomet (first American jet); (2) canal lock; (3) conestoga wagon; (4) Goddard's liquid fuel rocket; (5) hot air balloon; (6) magnetic levitation train (MAGLEV); (7) metric dragster; (8) operation sail; (9) reaction engine car; and (10) Wright Brothers airplane. Each of the 10 technology topic entries includes the title, descriptions of the transparencies, science concepts, mathematical concepts, and transparency masters graphically illustrating the topic. A list of additional documents available from the Division of Vocational-Technical Education, Maryland Department of Education is provided. (KR)

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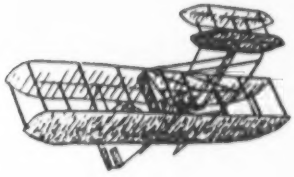
# TECHNOLOGY EDUCATION



## MATHEMATICS AND SCIENCE INTERFACE CURRICULUM PROJECT

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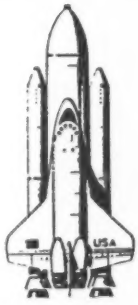

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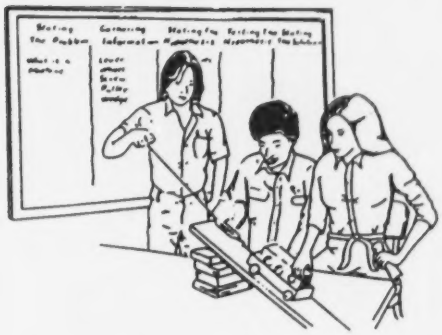
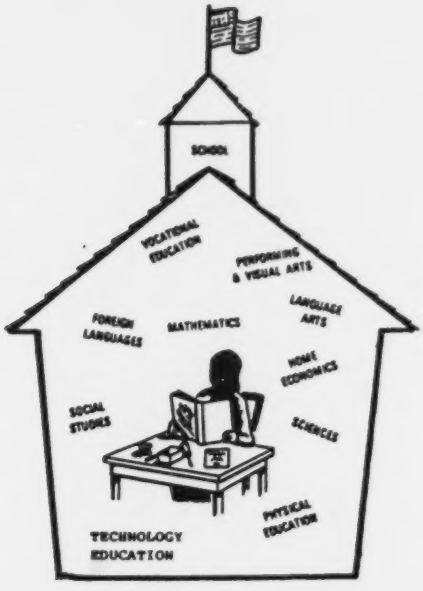
# MATH, SCIENCE, TECHNOLOGY EDUCATION INTERFACE



## A CURRICULUM PROJECT...

Aimed at enriching the content of industrial arts/technology education as well as demonstrating the potential for this area to make a significant contribution to the students' understanding of mathematics and science in the application of such disciplines in the technology education laboratory.

# THE PURPOSE...




There were four distinct purposes for understanding this project. Each of these have significant value; however, collectively they offer substantial rationale for pursuing holistic learning in our public schools.

They are...

To assist understanding and cooperative relationships in our schools between content areas of mathematics, science and technology education.

To provide for the integration of mathematics and science into the teaching of technology education.

To develop curriculum materials for the integration of mathematics and science into technology education.

To provide inspiration and direction for further content integration for all subjects.

# THE PROCESS...

The math/science/technology education project was a cooperative effort by concerned educators in the state of Maryland. It was a curriculum project aimed at enriching the content of technology education through the meaningful integration of mathematics and science. This integration should demonstrate the potential for technology education to make a significant contribution to the students' understanding of these subjects through their application in the technology education laboratory.

The project was conducted over a three year period, beginning in the summer of 1985, continuing in 1986, and concluding in 1987. Each year, teachers from public schools throughout Maryland were assembled for two weeks. The organization was provided by the Department of Industrial, Technological and Occupational Education at the University of Maryland, College Park Campus. During these two week periods, teams of educators were involved in the process of creating technology education instructional materials that integrated the subject areas of mathematics and science. Appropriately, each team represented one school and included one teacher from each of the following areas: Industrial Arts/ Technology Education, Math and Science. It was the responsibility of the technology teacher to lead the team by providing direction for content development. As each technology teacher identified the content from his/her program, the science and math teachers would analyze the content for science and math applications. The outcome of this effort was the creation of appropriate visual masters that would communicate technological content as well as applied science and math principles. This master would be supplemented with information sheets carefully developed by the math/science members of the team. The information sheets would describe in greater detail the specific science and mathematics principles related to the technology content topic.

Follow-up activities involved workshops and in-service sessions in each of the local education agencies participating in the project. Finally, these curriculum materials were prepared for distribution to all participants, as well as local education agencies throughout the state.

# ACKNOWLEDGEMENTS...

This document is the result of a major cooperative effort over a three period at all educational levels.

| | |
|---|---|
| Project Director... | Dr. Donald Maley, Professor Emeritus Department of Industrial, Technological, and Occuaptional Education, University of Maryland, College Park Campus. |
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| | Mr. Allan B. Myers, Specialist of Industrial Arts/Technology Education, Maryland State Department of Education, Division of Vocational-Technical Education. |
| Edited By... | Kenneth L. Smith, Technology Education Teacher, John Hanson Middle School, Charles County Public Schools. |

# ACKNOWLEDGEMENTS

Teacher Teams...
(1985)

Arbutus Middle School

| | |
|---|---|
| Technology Teacher | Steve Bartley |
| Science Teacher | Linda McCelland |
| Math Teacher | James Hastings |

Calvert High School

| | |
|---|---|
| Technology Teacher | Carl Fenwick |
| Science Teacher | Terrance Klazer |
| Math Teacher | Kevin Michael |

Catonsville High School

| | |
|---|---|
| Technology Teacher | Bill Gibbs |
| Science Teacher | Buddy Brietenbach |
| Math Teacher | Ken Berry |

Cherry Hill Middle School

| | |
|---|---|
| Technology Teacher | Wilson Thompson |
| Science Teacher | Gretchen Lawson |
| Math Teacher | Kermit Williams |

Franklin High School

| | |
|---|---|
| Technology Teacher | Howard Spears |
| Science Teacher | Stanislaus Ziolkowski |
| Math Teacher | Joseph Noto |

Gaithersburg High School

| | |
|---|---|
| Technology Teacher | Willie Hill |
| Science Teacher | Dr. Donald Poe |
| Math Teacher | Deno Diamonds |

Glen Burnie High School

| | |
|---|---|
| Technology Teacher | Art Chenowith |
| Science Teacher | John O'Dell |
| Math Teacher | Glenna Hilditch |

# ACKNOWLEDGEMENTS


Teacher Teams...
(1985)

John Hanson Middle School

| | |
|---|---|
| Technology Teacher | Kenneth L. Smith |
| Science Techer | Christine Smith |
| Math Teacher | Drew Jepsky |

North Carroll High School

| | |
|---|---|
| Technology Teacher | Stephen Shepler |
| Science Teacher | Dean Packer |
| Math Teacher | Babette Leister |

Sparrows Point Middle School

| | |
|---|---|
| Technology Teacher | Will Heilman |
| Science Teacher | Ruth Jensen |
| Math Teacher | Paul Leimbach |

# ACKNOWLEDGEMENTS


Teacher Teams...
(1986)

Einstein High School

| | |
|---|---|
| Technology Teacher | Robert Wotkowski |
| Science Teacher | Russell Wright |
| Math Teacher | Mary Carter |

John Hanson Middle School

| | |
|---|---|
| Technology Teacher | Kenneth L. Smith |
| Science Teacher | Christine Smith |
| Math Teacher | Drew Jepsky |

Oxon Hill High School

| | |
|---|---|
| Technology Teacher | Charles Algire |
| Science Teacher | Michael Mickolay |
| Math Teacher | Diana B. McCusker |

Prince George's County Schools

| | |
|---|---|
| Frank Grahn | George Miles |
| Robert Gray | Roland Moore |
| Connie Jones | Nelson Sharpe |

Roosevelt High School

| | |
|---|---|
| Technology Teacher | Joseph Irizarry |
| Science Teacher | Bobbie Smith |
| Math Teacher | Mike Reidy |

Springbrook High School

| | |
|---|---|
| Technology Teacher | David Kaplan |
| Science Teacher | Paul Kroeger |
| Math Teacher | Regina Skyles |

Wilde Lake High School

| | |
|---|---|
| Technology Teacher | Charles Venable |
| Science Teacher | Nicholas Zoulias |
| Math Teacher | Eric Ebersole |

Woodlawn Middle School

| | |
|---|---|
| Technology Teacher | Richard Harbach |
| Science Teacher | Cheryl Migliarini |
| Math Teacher | William Gluth |

# ACKNOWLEDGEMENTS

Teacher Teams...
(1987)

Chesapeake Middle School

| | |
|---|---|
| Technology Teacher | Thomas Eoannou |
| Science Teacher | Donald Stenimler |
| Math Teacher | Dione McManus |

Eastern Vocational-Technical School

| | |
|---|---|
| Vocational Teacher | Earl Crusse |
| Science Teacher | William Stacy |
| Math Teacher | Albert Smith |

Earle B. Wood Junior High School

| | |
|---|---|
| Technology Teacher | Mark Green |
| Science Teacher | Richard Knight |
| Math Teacher | Julia Pepeta |

Galena Middle School

| | |
|---|---|
| Technology Teacher | Charles Cooper |
| Science Teacher | Margaret F. Crow |
| Math Teacher | Kevin Smith |

Merganthaler Vocational-Technical School

| | |
|---|---|
| Vocational Teacher | Jack Jacobs |
| Science Teacher | Gail Brayton |
| Math Teacher | Dwight Evans |

North Caroline High School

| | |
|---|---|
| Technology Teacher | Len Harmon |
| Science Teacher | Patricia Clay |
| Math Teacher | Mike Miller |

North Carroll Middle School

| | |
|---|---|
| Technology Teacher | Robert Lenz |
| Science Teacher | Tim Hontz |
| Math Teacher | Linda Guillen |

# ACKNOWLEDGEMENTS

Teacher Teams...
(1987)

Owings Mill High School

| | |
|---|---|
| Technology Teacher | Roland Phelps |
| Science Teacher | Sherman Kopelson |
| Math Teacher | Sharon Oland |

Taney Middle School

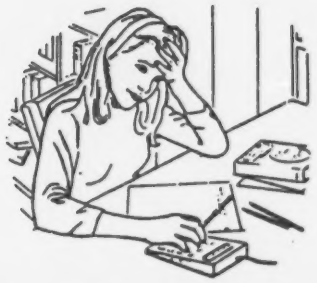
| | |
|---|---|
| Technology Teacher | Dennis Hearns |
| Science Teacher | Bruce Guinn |
| Math Teacher | John Davis |

West Frederick Middle School

| | |
|---|---|
| Technology Teacher | Paul E. Dunford |
| Science Teacher | Paula Lawton |
| Math Teacher | Rose Geiger |

# CONTENT INTEGRATION

## A RATIONALE...

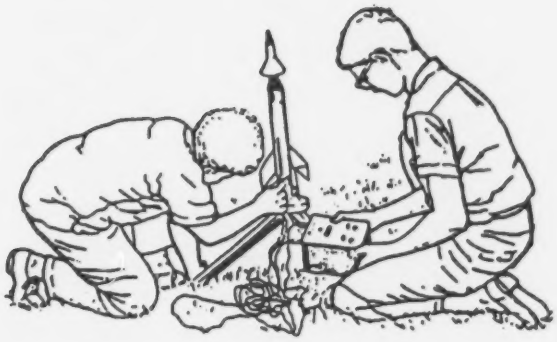


If technology education is to seriously provide for greater understanding and awareness of technological achievement, the issue of holistic learning must be addressed. If one is to truly understand any technological achievement, anthropological or contemporary, a discovery and realization of the specific scientific and mathematical concepts must be accomplished. To illustrate: a student studying rocket technology can use a few tools and machines to build a model of a rocket in any technology education laboratory. However, if that student is to gain a meaningful understanding of rocket propulsion, the scientific and mathematical relationships causing a rocket to function must become part of the instructional activity. Without this effort, the student is involved in a very superficial program.

It is most important to remember that the constructive activity is a vital part of the technology education experience. Generally, constructed items in class serve to motivate students. This motivation can be used to initiate further investigation into a particular curricular topic. Leading a student into a deeper understanding of a "cause and effect" relationship behind a technical device should be a carefully planned and managed instructional process. This process demands the inclusion of science and mathematics; that is, if understanding is the desired outcome.

Technology education offers, within its content and methodology, a prime vehicle through which the subjects of the school can be unified for relevant, meaningful learning on the part of the student. This is particulary true for mathematics and science. Technology education teachers permit students the opportunity to discover through investigation, research and problem solving the "how and why" relationships of science, math and technology education. This approach to subject integration would then continue and enhance the vital "experiential-active" quality that technology education has always valued.

# TECHNOLOGY EDUCATION



## A DEFINITION...

Technology education is an experienced-based curriculum area in which students study technology... its evolution, utilization and significance. It develops the technological literacy everyone needs. It involves learning experiences, including the application of mathematics and science, in such areas as communications, construction, manufacturing, power and energy, transportation, including the impact of these areas on the environment and society.

# TECHNOLOGY EDUCATION

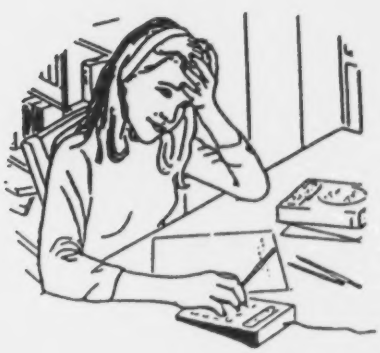
## OPPORTUNITIES TO...

Acquire knowledge, understandings and skills needed to function in a technological environment.

Integrate and apply concepts and skills of mathematics, science and communication.

Explore societal and environmental impacts of technology.

Solve problems through laboratory experiences which incorporate creative inquiry, ingenuity, discovery and interaction with technology.



# LONG-RANGE OUTCOME...

It is most desirable that this curriculum integration effort will provide direction for not only technology educators, but all concerned educational personnel pursuing meaningful, holistic learning in our public schools. However, as with any curriculum development experience, its usefulness depends on further creation and appropriate implementation by teachers in their classrooms. This body of work has already furnished sufficient guidance for some workshop participants to design and utilize additional materials suitable for use in their particular programs.

It has been convincingly argued that technology education can lead the way for meaningful, relevant subject integration in our schools. The effort in this curriculum project supports that argument. If teachers from the content areas of mathematics, science and technology education can cooperatively discuss, plan, design and produce curriculum materials such as those included in this document, certainly individual schools or local educational agencies should be able to coordinate similar activities. Technology educators should take this opportunity to provide the leadership necessary for further holistic curriculum exploration. Just as leadership and direction was provided by technology educators during this project, continued educational attempts to integrate mathematics and science into the technology education curriculum should be guided by individuals in technology education. The technology laboratories and curricula offer students that place within the school that can bring real understanding to all subjects.

The instructional materials contained in this document serve as examples of successful curriculum integration. The key to this success was carefully managed cooperation among concerned educators. Continued usefulness of these materials will certainly depend on carefully planned and supervised strategies. It is suggested that this document provide the impetus for workshops, seminars and various other in-service activities at all educational levels. The goal... appropriate and meaningful application of mathematics and scientific concepts into technology education.

# CLASSROOM USE...

One of the goals of this document is to provide for continued mathematics, science and technology integration. With this in mind, it is suggested that these materials can be used in two significant ways. However, it is important to realize that effective use of this document greatly depends on the initiative of technology teachers, resource teachers and supervisory personnel.

First, this document can serve as an instructional materials resource collection. The teams of educators who participated in the three year workshop have produced an extensive variety of technology topics presented as part of their individual programs. Each topic includes detailed information sheets identifying the mathematical and scientific principles that could be studied in the technology education activity. The quantity and depth of study for these math and science concepts remains at the discretion of the technology teacher. Variations in content usefulness will also depend on individual school or classroom conditions as well as the grade level of students.

Because of the wide range of technology topics presented, many teachers will be able to simply review and select items appropriate for immediate use in the classes. Some will be useful with only minor modifications to subject content. After basic planning and curriculum consideration, most technology teachers should be able to include some of these materials as part of their technology instuction.

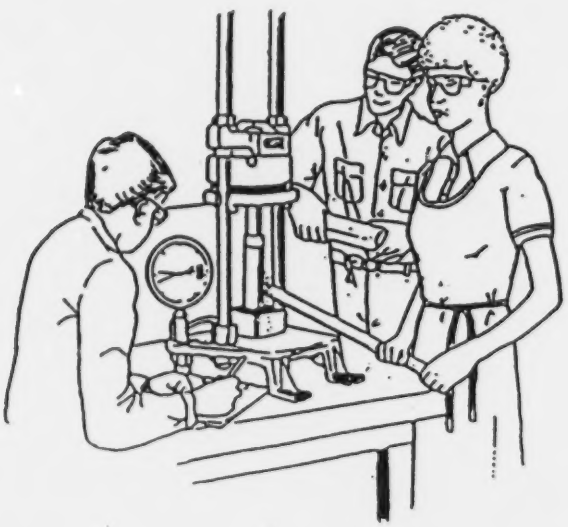
Secondly, this document can serve as a materials resource guide. This is accomplished by providing a format and process for the creation of similar classroom instructional materials. It is suggested that after reviewing these materials and understanding the cooperative 'teaming' process used in their creation, technology teachers will adopt a similar approach as they develop classroom materials appropriate to their programs. Although technology teachers generally possess backgrounds in mathematics and science, it is most valuable to pursue the assistance of the school's mathematics and science personnel in the identification of those principles peculiar to their programs. This effort will insure accurate and relevant subject integration with the technology education curriculum. In addition, math and science teachers could also reinforce technology education concepts in their curricula.

# ORGANIZATION...

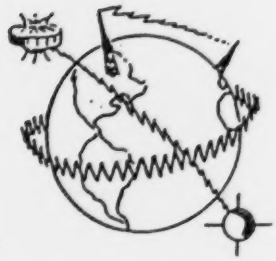
This document is organized into five categories. These categories are selected from the content areas identified in the definition of technology education.

Each technology topic has been placed in the most appropriate content area. However, some topics may be appropriate in more than one area.

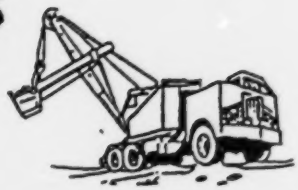
Each content category includes a statement of definition and a point of view.



## CONTENT AREAS:

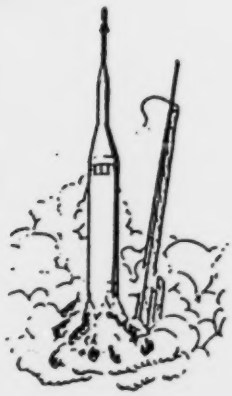


- COMMUNICATIONS



- CONSTRUCTION

- MANUFACTURING
- POWER AND ENERGY
- TRANSPORTATION



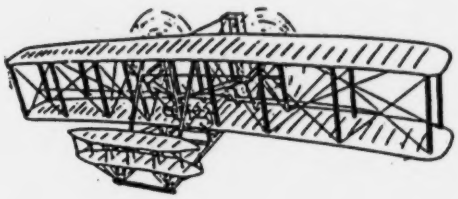
# TRANSPORTATION

## Point of View...

The need for movement of people from place to place has lead to the creation of unique and efficient vehicles. From the earliest efforts of harnessing animals for transportation to the sophisticated, rapid technologies that exist today; the direction is quite clear... reduce time and distance.

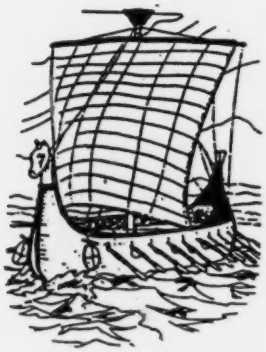
The world has shrunk tremendously during the last 100 years. We have gone from... around the world in eighty days to actually circling the globe in less than eighty hours in modern aircraft, including plenty of time to see the sights. Within a few years, that eighty hours will probably be substantially reduced. Discoveries in the areas of power and energy are occuring at tremendous rates. These new discoveries are being applied to innovative transportation devices or reviving forgotten ones.

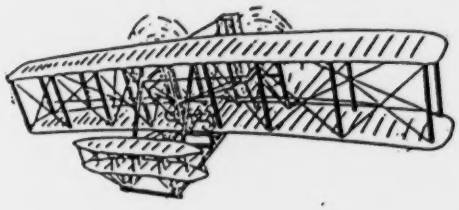
As with all technologies, transportation technology changes according to society's demands. As the society moved from agrarian to industrial to super industrial, and now the information age, the demands for much faster and more efficient methods for movement of people and things has become staggering. More members of society require rapid transportation in their professional needs for products and private lives. The business community has developed extraordinary transportation needs for products and personnel. In addition, the final frontier, space, has presented engineers and researchers with problems related to time and distance that are almost unbelievable. How will these challenges be met? The answer, as expected, is technological achievement. But in order for new technologies to arrive, engineers, designers, and researchers must intelligently apply scientific and mathematical concepts related to speed, safety, efficiency, as well as the consequences associated with pollution, social and environmental impact.



# TRANSPORTATION

AS A CONTENT AREA IS THE STUDY OF TECHNOLOGIES CREATED TO MOVE PEOPLE AND THINGS FROM ONE PLACE TO ANOTHER. INCLUDED ARE VEHICULAR AND NON-VEHICULAR TECHNOLOGIES THAT CONVERT ENERGY INTO MOTION ON... LAND, WATER, AIR AND SPACE.





## VEHICULAR TECHNOLOGIES:

AUTOMOBILES

AIRCRAFT

HUMAN POWERED VEHICLES

SHIPS

SPACECRAFT

ANIMAL POWERED VEHICLES

## NON-VEHICULAR TECHNOLOGIES:

PIPLINES

CONVEYORS

ESCALATORS

# TRANSPORTATION
## TECHNOLOGY TOPICS

BELL XP-59A AIRACOMET...FIRST AMERICAN JET

CANAL LOCK

CONESTOGA WAGON

GODDARD'S LIQUID FUEL ROCKET

HOT AIR BALLOON

MAGNETIC LEVITATION TRAIN (MAGLEV)

METRIC DRAGSTER

OPERATION SAIL

REACTION ENGINE CAR

WRIGHT BROTHERS AIRPLANE

# ADDITIONAL DOCUMENTS

The following documents are also available from the Division of Vocational-Technical Education, Maryland State Department of Education.

## POWER & ENERGY

ANEMOMETER
AUTOMOTIVE AIR CONDITIONING
- ACCUMULATOR
- COMPRESSOR
- CONDENSER
- EVAPORATOR

BASIC ELECTRICAL CIRCUITS
BATTERY
BIMETAL DEVICES
CARBURETOR
CAPACITORS
CASTER
CATALYTIC CONVERTER
COMBUSTION CYCLE
COMPUTER COMMAND CONTROL
CONDUCTORS
COPPER WIRE RESISTANCE
DIESEL COMPRESSION RATIOS
DIODE
DRY CELL BATTERY
ELECTROMAGNETIC FIELD STRENGTH...
- CORE PERMEABILITY

ELECTROMAGNETIC RELAY
ELECTROMAGNETS
ELECTRON BEAM DEFLECTION
ELECTRONIC MAIE
FLYBALL GOVERNOR
FOUR STROKE ENGINE
FULL WAVE RECTIFICATION
GEARS
HALF WAVE RECTIFICATION
HYDRAULICS
IMPULSE STEAM TURBINE
IMPULSE WATER TURBINE
INCANDESCENT LAMP
LASER
LIFT PUMP
LIGHT EMITTING DIODES
LOGIC INVERTER
MAGNETIC COMPASS
MICROWAVE OVEN
MOVING COIL AMMETER
NEWCOMEN STEAM ENGINE
OHM'S LAW
OVERSHOT WATER WHEEL
PARABOLIC FURNACE
PARALLEL CIRCUITRY
PASSIVE SOLAR HEATING
RELATIONSHIP OF VOLTAGE TO BOYLE'S/CHARLES' LAWS
RESISTORS
ROCKET ENGINES
ROCKETRY
SERIES CIRCUITRY
SERIES-PARALLEL CIRCUITRY
SILICON PHOTOVOLTAIC CELL
SIMPLE MACHINES
SMOCK WINDMILL
SOLAR ENERGY
SOLAR HEATER
SOLAR WATER HEATER
TRANSFORMERS
TRANSISTOR OPERATION
TURBOCHARGING
TWO STROKE ENGINE
WIND TUNNEL
WIND TURBINE
WOOD BURNING STOVE

## CONSTRUCTION

ABRASIVE TECHNOLOGY
ARCHITECTURAL MATERIALS UNDER COMPRESSION LOAD
BENDING WOOD
BRIDGE CONSTRUCTION
BRIDGE TRUSS
CHARPY IMPACT TESTING
CONCRETE STRENGTH
COPPER ELECTROPLATING
DECK CONSTRUCTION
DIMENSIONAL CHANGE IN WOOD
HAMMER
HARDENING OF STEEL
HEAT TREATING METALS
HOUSE CONSTRUCTION
JOINING WITH SILVER SOLDER
MITER JOINTS
NAILING
ROOF FRAMING
SCREWDRIVER
STEEL
TRUSSES
WALL INSULATION

## COMMUNICATIONS

BELL'S LIQUID TELEPHONE
CAMERA
CRYSTAL RADIO
DYNAMIC MICROPHONE
EARLY RADIO
EARLY TELEVISION
EDISON'S PHONOGRAPH
FIBER OPTICS
HOLOGRAPHY
LIGHTHOUSE
PERISCOPE
PHONOGRAPH
PHOTO ENLARGER
PINHOLE CAMERA
PRINTING PRESS
PROBLEM SOLVING
RADAR
RADIO SYSTEMS
SATELLITE TELEVISION
SPEAKER CONSTRUCTION
SUNDIAL
TELEGRAPH
TELEPHONE OPERATION
TELESCOPE
TELEVISION CAMERA

## MANUFACTURING

BANDSAW
BICYCLE FRAME BRAZING
BLIND POP RIVETING
BOARD FOOTAGE
BUFFING WHEEL
DESIGN AND CONSTRUCTION-FIBERGLASS BOAT
DIP MOLDING
DRILLPRESS
DRILLS
ELECTRIC SPOT WELDING
INJECTION MOLDING
JIGSAW
LASER DRILLING-WELDING
LATHE CUTTING SPEEDS
MICROMETER
OXYGEN-ACETYLENE TORCH
ROTATIONAL MOLDING
SOLDERING
THERMOFORMING
TIN SNIPS
WOOD FINISHES
WOOD LAMINATING
WOOD STAINS
WOOD TURNING
WOOD WAXES

TITLE: BELL XP-59A AIRACOMET

CATEGORY: INNOVATION

DESCRIPTION:

The turbojet is shaped like a tube or cylinder. This tube is open at both ends. Air is brought into the front of the tube by an air compressor and the forward motion of the aircraft. The compressor then forces the air into combustion chambers where high grade kerosene is added and ignited.

The burning mixture creates high temperature and pressure inside the combustion chambers. As the gases push toward the rear, they spin a large turbine. As the turbine spins, it drives the compressor.

The escaping gases also cause an imbalance of forces inside the engine. The greater force at the front of the engine pushes it forward. This push is called thrust.

SCIENCE CONCEPTS:

1. Heat engines use heat energy to do work.
2. Heat engines operate on the principle that when a gas is heated its pressure increases.
3. Boyle's Gas Law states the volume of a gas varies inversely with the pressure applied to it, provided the temperature remains constant.
4. Charles' Gas Law states the volume of a gas varies directly with the temperature applied to it, provided the pressure remains constant.
5. Heat losses prevent heat engines from being perfectly efficient.
6. The four basic strokes of an internal combustion engine are intake, compression, power, and exhaust.
7. Energy is needed for work to be done.
8. Work is the result of a force acting on a body and moving it through a distance.
9. Simple machine--a device that helps you do work by increasing force, increasing speed, or changing the direction of the force.

   Wheel and axle--a simple machine that is a type of lever.

   Lever and fulcrum--a bar or board that is free to pivot about a fixed point.

   Gears--a kind of wheel-like machine that acts like a lever.
10. Friction is a force that acts to slow down a moving object that is passing through or against a material. A force is a push or pull.

SCIENCE CONCEPTS:

(CONTINUED)

11. Bernoulli's Principle: If a fluid is moving along a surface, the fluid will cause a force on that surface. This force will be perpendicular to the surface. If the fluid moves faster, it will cause less force on the surface.

12. Lift is the upward force of air moving around an object.

    Lift is increased by--

    a) increasing the surface of the blade.
    b) increasing the angle of attack.

13. Drag is friction created when objects move in air.

MATHEMATICAL CONCEPTS:

1. Simple formulas

   a) $T = \frac{M_s (V_2 - V_1)}{g}$

   $M_s$ = mass flow, lb./sec.
   $V_2 - V_1$ = change in velocity
   g = acceleration of gravity, or 32.2

   b) F = M x A
   Mass x Acceleration (Ft./Sec.$^2$)

   c) $F = \frac{w}{g} \times (V_2 - V_1)$

   Where: F = Force in pounds
   w = Flow rate in lbs./sec. of air, gas, or a liquid, such as fuel
   $V_1$ = Initial velocity of a mass of air, gas, or a liquid in ft./sec.
   $V_2$ = Final velocity of mass of air, gas, or a liquid in ft./sec.
   g = Gravitational acceleration, 32.2 ft. sec./sec.

   Note: $M = \frac{w}{g}$; where M = Mass

2. Boyle's Law

   $\frac{V_1}{V_2} = \frac{P_2}{P_1}$ V = Volume
   P = Pressure

3. Charles' Law

   $\frac{V_1}{V_2} = \frac{T_1}{T_2}$ V = Volume
   T = Temperature

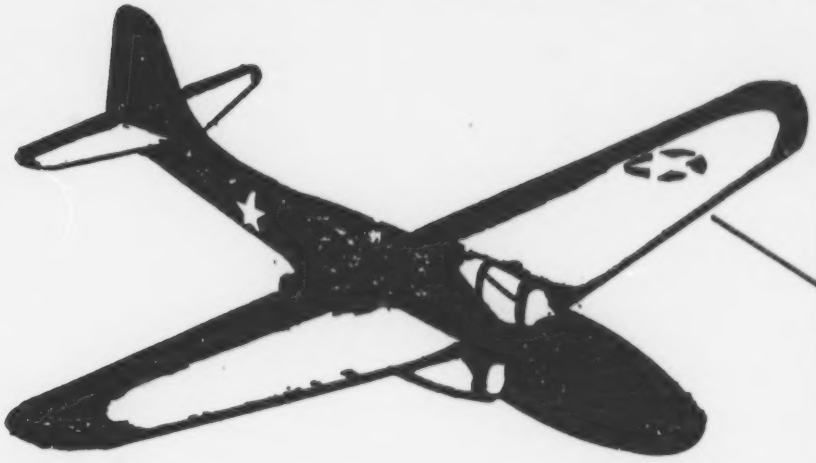
4. Mathematical operations

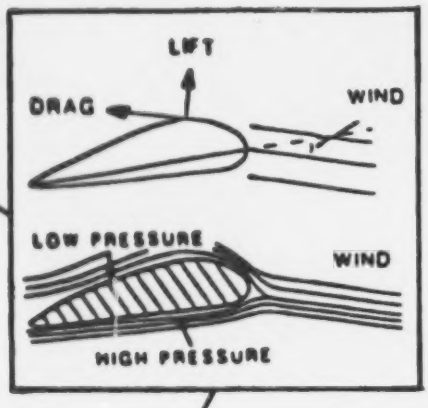
5. Order of operations

6. Solving equations

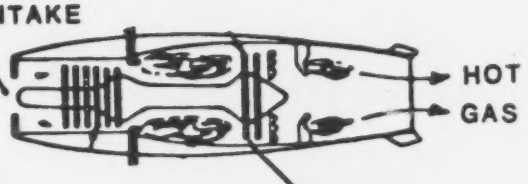
# BELL XP-59A AIRACOMET

## FIRST SUCCESSFUL AMERICAN JET AIRCRAFT

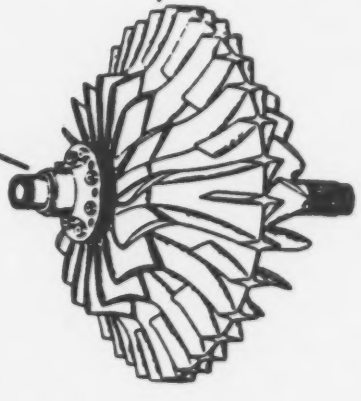


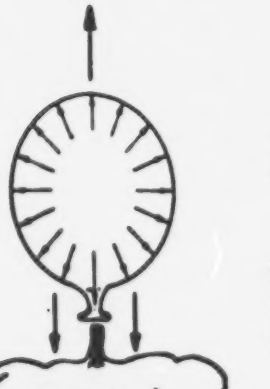



BERNOULLI'S PRINCIPLE




TURBINE





NEWTON'S THIRD LAW OF MOTION

KINETIC MOLECULAR THEORY

ENERGY CONVERSION

DISTANCE

VELOCITY x TIME

CHEMICAL → HEAT → MECHANICAL

Title: Canal Locks

Category: Innovation

Description:

As surely as canals were a revolutionary development in transportation, canal locks opened even more possibilies. Basically they provide a solution to the problem of moving ships from one level of water, via canals, to another level of water. Some canals use only one lock, whereas a series of locks will accommodate a greater difference in water levels. Canal locks are stone or concrete chambers with watertight gates at either end. A ship enters the lock, the gates close behind it, and water is drained from the lock until the water level within the chamber equals that in the next lock. The other set of gates is opened and the ship passes into a next lock. This procedure is repeated until the ship has finally passed through the canal. Canal locks facilitate the passage from lake, to lake through mountains, or across an isthmus, joining continents and oceans, saving thousands of miles and countless hours.

Title: Canal Lock

Category: Innovation

Science Concepts:

Definitions:

1. Drag - The friction of a fluid as it rubs on an object.
2. Force - A push or a pull.
3. Inertia - The resistance of an object to being moved.
4. Lever - A rigid bar that rotates about a point.
5. Water Pressure - The force that water applies against objects.

Principles:

1. The gates on the lock must be made very strong because there is a great amount of water pressure on them. The pressure is related to the depth by the formula, $P = Dh$, where P = water pressure, D = density of water (62.4 pounds/foot $^3$), and h = height or depth. With this formula it can be shown that the water pressure on the bottom of a 20 foot tall gate would be 1248 pounds per square foot.
2. To provide more strength the lock doors are constructed as class two levers. The fulcrum of the lever is the edge of the canal, the effort arm is leaning against the other lock gate and the resistance is the water pressure in the lock. Because the edge of the canal is used as the fulcrum the edge of the lock must be reinforced for strength.
3. To open the lock gates takes a great deal of force. There are two reasons it takes so much force. The first reason is because the gates are built very heavy to resist the water pressure. This weight causes the gates to have a great deal of inertia. The second reason is the drag of the water on the gates. Since the gates are so hard to open, a class one lever is employed.

Title: Canal Lock

Category: Innovation

Science Concepts:

Definitions:

4. The locks can be filled and emptied using the water pressure in the canal and locks. Since water flows from areas of high pressure to areas of lower pressure, the water will flow from the part of the canal or lock with the higher water level to the part with the lower water level. Therefore, if a ship is to move up in the lock, the gates are closed and water is allowed to flow through a door in the upper gate until the water level in the lock and canal are equal. When the water level is equal, the pressure is the same in the lock and canal and the lock gates can be opened.

Title: Canal Locks

Category: Innovation

Math Concepts:

1. Volume and Capacity:

Canals are rectangular prisms. Their capacity for holding water is the product of the three dimensions of length, width and height. Displacement of water by an entering ship is determined by the weight of the vessel. The weight of the volume of water displaced is equal to the weight of the ship.

2. Measurement:

Common Fractions - For the student to construct a model of a canal lock, they must develop facility with measuring instruments and knowledge of fractional parts of units. The inch is subdivided into fractional parts whose denominators are powers of two.

$$\frac{1}{2} \times \frac{1}{2} = \frac{1}{2}\,2 \text{ or } \frac{1}{4}$$

$$\frac{1}{2} \times \frac{1}{4} = \frac{1}{2}\,3 \text{ or } \frac{1}{8}$$

$$\frac{1}{2} \times \frac{1}{8} = \frac{1}{2}\,4 \text{ or } \frac{1}{16}$$

This relates to powers, exponents and multiplication of fractions. Developing this concept further leads us to an understanding of the Density Property of Rational Numbers. Theoretically each fraction can be further subdivided into an evan smaller fraction. A Rational Number consists of a Whole Number numerator and a denominator of some Counting Number. Since both of these number systems are infinite the set of Rationals between any two whole numbers is dense.

Title: Canal Locks

Category: Innovation

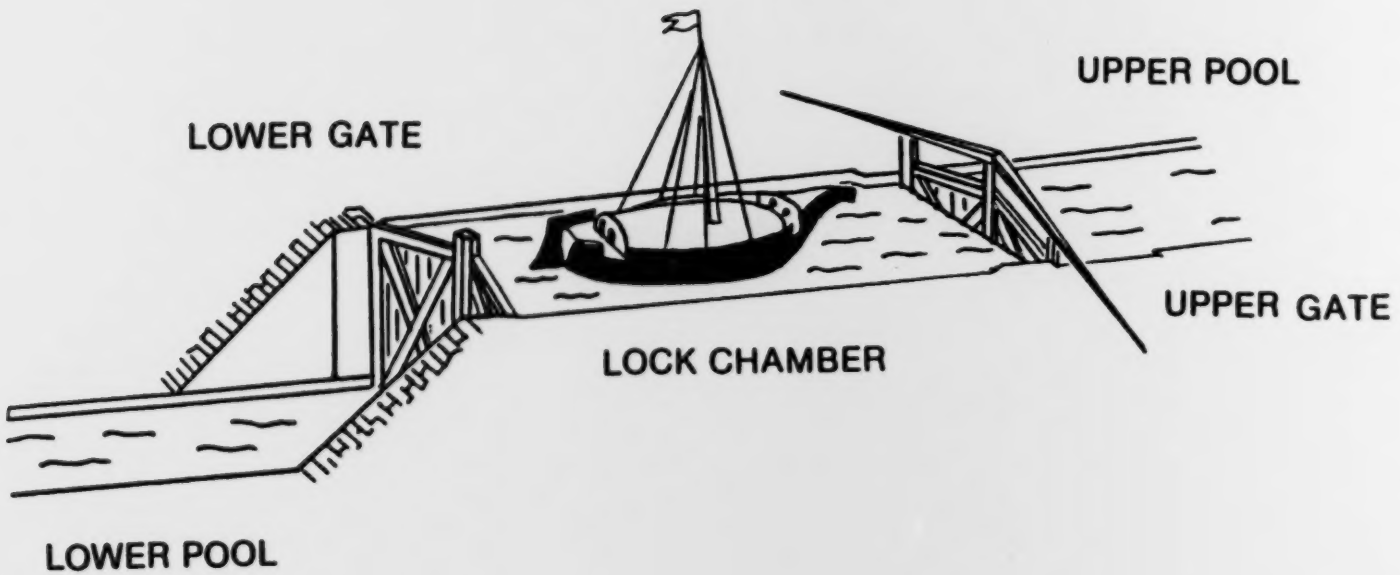
Math Concepts:

Decimal Fractions - The use of Metric units of measure necessitates a comprehension of decimal fractions. Prerequisite to converting from one unit to another is the skill of multiplying and dividing by powers of ten and its net effect on the decimal point.

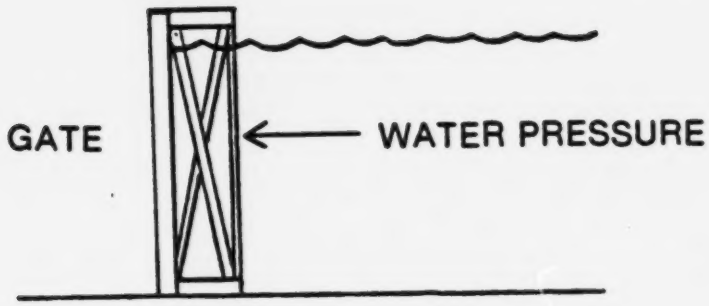
3. Ratios:

The student is required to draw an illustration of his/her project prior to construction. A scale must be determined to accomodate the transition from plane paper to a three dimentional product. A scale is a ratio whereby each segment of linear measure must be multiplied by the same factor. Angles, however, remain the same, thereby maintaining the integrity of shape while the size is dilated. This model is a useful illustration for the math teacher who is trying to distinguish between congruent, (same size and shape), and similar, (same proportionate shape).

# CANAL LOCK



# CANAL LOCK



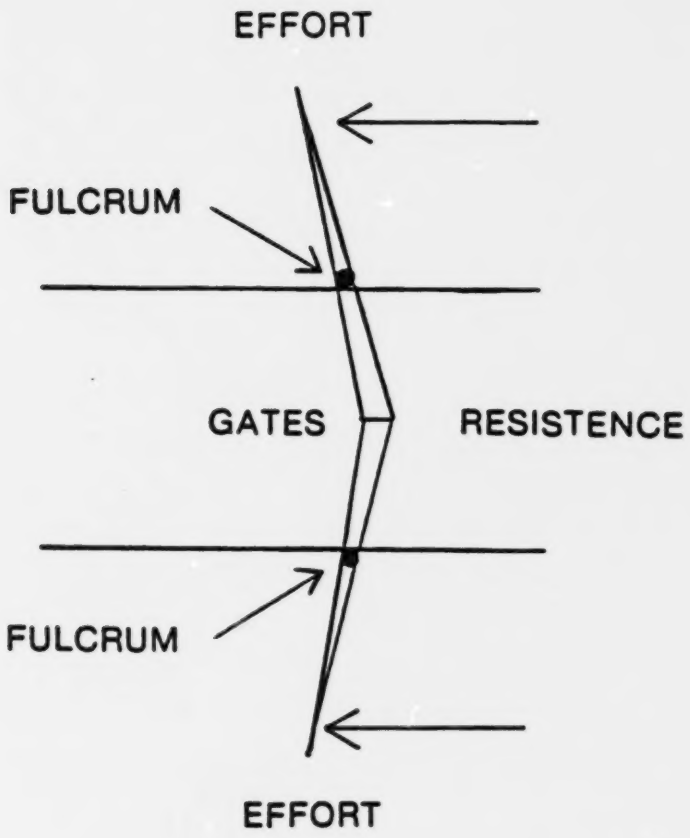

$$P = Dh$$

P = WATER PRESSURE

D = DENSITY OF WATER

h = HEIGHT (DEPTH)

# CANAL LOCK



Title: Conestoga Wagon

Category: Construction

Description:

A Conestoga Wagon was a stanchly built, brightly painted covered wagon used by American pioneers. It was first built in the early 1700's. Conestogas carried most of the freight and people that moved west over the Alleghenies from the time of the Revolutionary War until about 1850. These wagons were sometimes called the "camels of the prairies".

Both ends of the wagon were built higher than the middle. The white canvas roof was high and rounded. The wheels could be removed and the wagon could be used as a boat. They were drawn by teams of from four to six horses.

Title: Conestoga Wagon

Category: Construction

Science Concepts:

1. LAW OF INERTIA - The property of matter which makes it necessary for a force to be exerted on it in order for it to be accelerated.
2. NEWTON'S LAW OF THE MOTION - If an object is not moving, it will not move at the same speed in a straight line unless an unbalanced force is applied to it.
3. Potential energy is stored energy.
4. Kinetic energy is energy of motion.
5. FRICTION - Resistance to relative motion between two surfaces in direct contact. Also, loosely, the rubbing together of two surfaces. Brakes on the wagon would be an example of this.
6. THERMAL EXPANSION OF THE WOOD - Wood like many other fibrous materials, shrinks as it dries and swells as it absorbs moisture.
7. ABSORPTION OF THE WOOD - Would absorb shocks and vibrations to a considerable extent. The wagon traveled on various roads or paths and absorption of shock was very important.
8. POROSITY- Arrangement of certain size and arrangement of the elements, varying within certain limits are characteristic of each wood or group of woods and help in identifying the different kinds and in judging their qualities.
9. STRENGTH - The term in its broader sense embraces collectively all the properties of wood which enable it to resist different forces or loads. In its more restricted sense, strength may apply to any one of the mechanical properties, in which event the name of the property under consideration should be stated, thus strength in compression parallel to the grain, strength in bending, hardness, etc.

Title: Conestoga Wagon

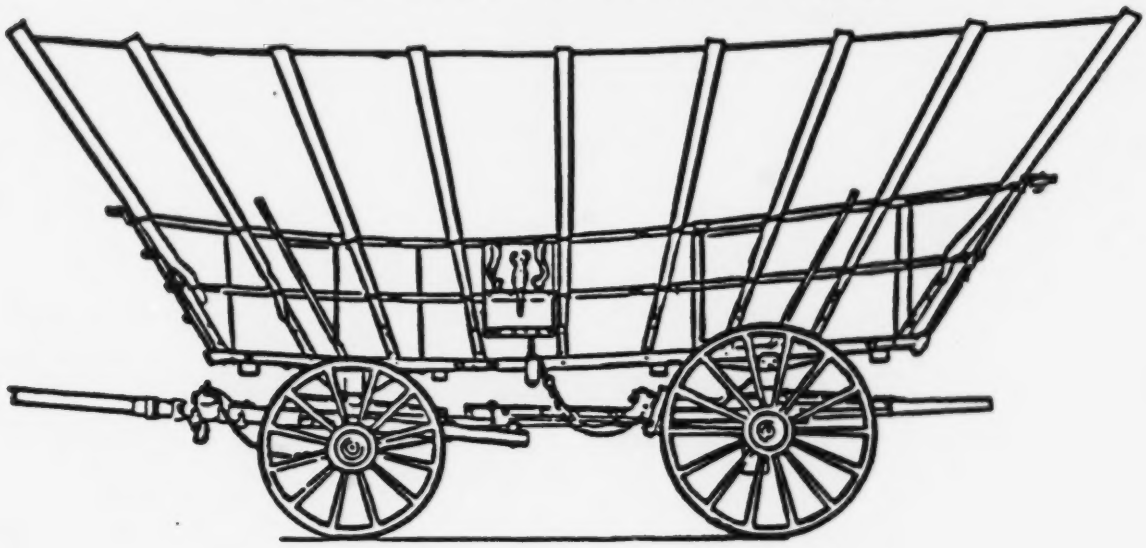
Category: Construction

Math Concepts;

1. BASIC MEASUREMENT SKILLS
2. GEOMETRY
   - CIRCLES
   - ANGLES
   - AREA
   - PERIMETER
3. $K.E. = \frac{1}{2}MV^2$ — Kinetic energy = ½ mass x velocity$^2$
4. $W = fs$ — Work (ft/lbs) = force (lbs) x distance (ft.)
5. $U = L/A$ — Unit stress (Pounds per sq. in.) = load (pounds) $\frac{\text{load (lb.)}}{\text{area(sq.in.)}}$
6. WEIGHTS AND MEASUREMENTS
7. $P = \frac{W}{t}$ — Power = $\frac{\text{force x distance}}{\text{time}}$
8. $h.p. = \frac{P}{33{,}000}$ — Horsepower = $\frac{\text{Power}}{33{,}000}$
9. $d = r \times t$ — Distance = rate x time

# CONESTOGA WAGON

## THE CAMEL OF THE PRAIRIE



1750 - 1850

### SCIENCE CONCEPTS

POTENTIAL ENERGY

LAW OF INERTIA

FRICTION

ABSORPTION

THERMAL EXPANSION

NEWTON'S LAW OF MOTION

### MATH CONCEPTS

GEOMETRY

(PERTAINING TO CIRCLES)

PERIMETER

MEASURING SKILLS

$K.E. = \frac{1}{2}MV^2$

K.E. = KINETIC ENERGY

M = MASS

V = VELOCITY

TITLE: GODDARD'S LIQUID FUEL ROCKET

CATEGORY: INNOVATION

DESCRIPTION:

On March 16, 1926 Robert Goddard tested the first liquid propellant rocket. It was built so that it consisted of a large liquid oxygen tank and a smaller petrol tank linked by slim pipelines to the firing chamber. This particular rocket travelled a distance of 184 feet at a speed of 64 m.p.h. and stayed airborne for 2 ½ seconds.

SCIENCE CONCEPTS:

1. Energy conversion occurs as chemical energy is transferred to heat and then to mechanical energy.

2. Chemical reaction of fuel and oxygen occurs in the combustion chamber.

3. Kinetic molecular theory states that all matter is made of molecules. As the temperature of the molecules increases, so does the movement of the molecules. As the movement of the molecules increases, so does the pressure inside the closed container.

4. Thrust is a forward push or force produced by a jet or rocket engine. Thrust is measured in pounds.

5. Newton's First Law of Motion states that an object in motion stays in motion or an object at rest stays at rest unless an unbalanced force is applied.

6. Newton's Second Law of Motion states that a force proportional to the rate of change of the velocity is produced whenever a body (mass) is accelerated.

7. Newton's Third Law of Motion states that to every action there is an equal and opposite reaction.

MATHEMATICAL CONCEPTS:

1. Formulas--

   a) Work = Force x Distance

   b) Thrust = $\frac{M_s (v_2 - v_1)}{g}$

   $M_s$ = mass flow, lb./sec.
   $v_2 - v_1$ = change in velocity
   $g$ = acceleration of gravity, or 32.2

   c) Force (lbs.) = Mass x Acceleration ($ft./sec^2$)

2. Solving Equations

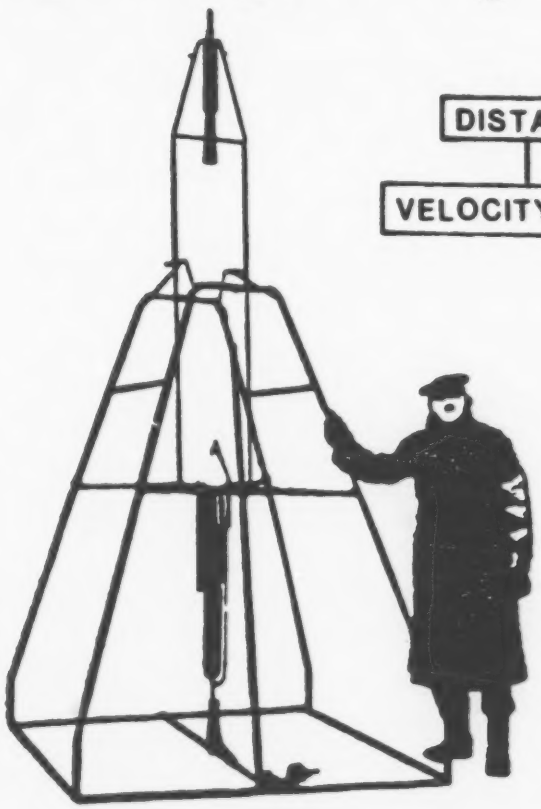
3. Ratio/Proportions

# GODDARD'S LIQUID FUEL ROCKET

ENERGY CONVERSION

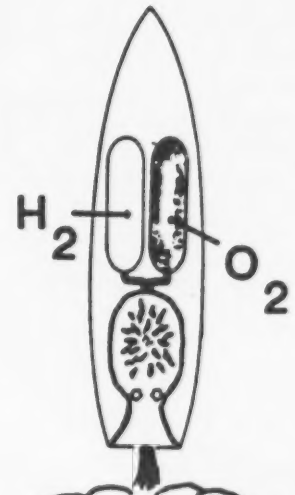
CHEMICAL → HEAT → MECHANICAL

$2H_2(l) + O_2(l) = 2H_2O \uparrow$



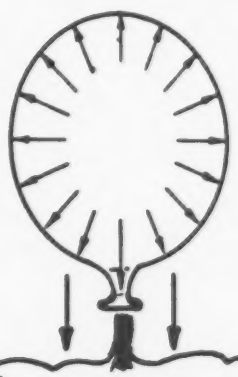
DISTANCE

VELOCITY x TIME




THRUST

LIFT



NEWTON'S THIRD LAW OF MOTION

KINETIC MOLECULAR THEORY

BEST COPY AVAILABLE

TITLE: HOT AIR BALLOON

CATEGORY: INNOVATION

DESCRIPTION:

By applying the principle that hot air rises, the modern day ballonist ascends rapidly. To moderate the rate or climb, which can be up to 2000 feet per minute or to descend, a vent in the balloon envelope can be opened. Once the hot, thin air escapes, the craft begins to drop. A further blast on the heater will stabilize the balloon. Through subtle changes in altitude pilots can "steer" their craft to a limited degree and flights can be planned to use the predictable changes of wind direction at various heights.

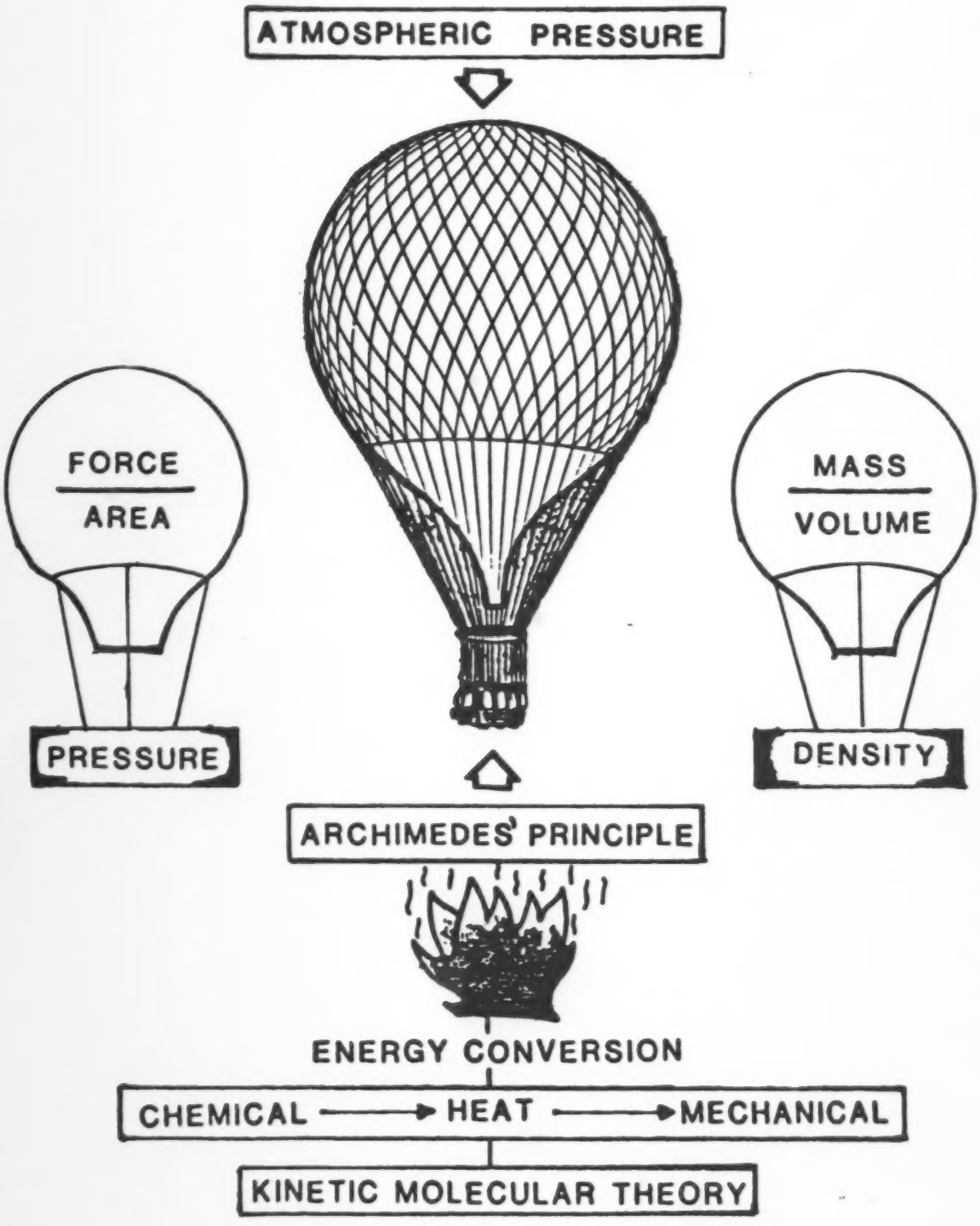
SCIENCE CONCEPTS:

1. Energy is needed to do work.
2. Energy is transferred from chemical to heat to mechanical.
3. The kinetic molecular theory states that all matter is made of molecules. As the temperature of the molecules increases, so does the movement of the molecules.
4. Atmospheric pressure is the pressure exerted by the air as a result of the weight of the earth's atmosphere.
5. Atmospheric pressure decreases as height increases because the weight of overlying air layers decreases with increasing altitude.
6. Density is the mass of a substance divided by its volume.

MATHEMATICAL CONCEPTS:

1. Density = $\frac{\text{mass (g)}}{\text{volume } (cm^3)}$
2. Volume
3. Wind Speed
4. Archimedes Principle
5. Pressure = $\frac{\text{Force}}{\text{Area}}$
6. Mathematical Equations with Variables
7. Metric System--Units of Mass, Volume
8. Metric Prefixes

# HOT AIR BALLOON



Title: Maglev Train

Category: Research and Experimentation

Description:

Magnetically levitated superfast trains are one of the many potential benefits of high-temperature super-conductors. The principle behind the maglev is simple: opposite magnetic poles attract each other; like poles repel. Depending on the design of the train and rail system the electromagnets can repel each other to lift the train (repulsion system) or the train can pull itself upwards toward the rail (attraction system).

Technological Impact

Social Impact: Elimination of heat caused by electrical resistance could have a profound effect on the design and size of computers. This could also result in miniaturization of all electric motors.

Maglev trains could result in a faster, more efficient, less costly means of transportation for the public.

As much as 20% of the energy sent through high-tension lines is now lost. Electricity sent through superconducting cable loses no energy. This would result in a savings for the utility companies and ultimately the consumer. A few underground cables could supply the electrical needs for a city.

Environmental Impact - In any industry where superconducted electricity could be substituted for fossil fuels a reduction of air pollutants would result.

Title: Maglev Train

Category: Research and Experimentation

Science Concepts:

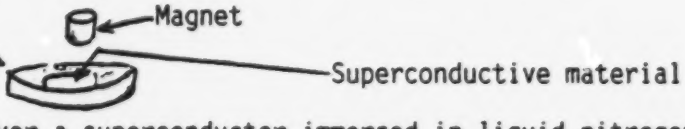
1. Conductors - materials that carry an electric current well.
2. Insulator - material that electricity cannot go through.
3. Laws of Electric Charge -
   A. Like charges repel (+,+) (-,-)
   B. Opposite charges attract (+,-).
4. Electrons - tiny particles that spin around the outside of an atom. Electrons have a negative charge. An electric current in a metal is made of moving electrons.
5. Electric Circuit - the path that an electric current follows. Moving electrons make an electric current.
6. Resistance - a measure of how easy or hard it is for electric current to move through a material.
7. Superconductors - when a wire is cooled, its resistance gets lower. Some materials lose all their resistance at very low temperatures. (Mercury becomes a superconductor at $270^{O}$ below zero Celsius). Superconductive materials lose resistance because the electrons are bound in pairs, current flows with no energy loss or resistance.
8. Electromotive Force -. is the push that makes electricity move (EMF).
9. Volt - the measure of electromotive force (Portable radios use 9 volt batteries.
10. Magnets - (North pole, South pole), some metals make good magnets (iron, cobalt, nickel). Their atoms line up so they face the same way. A moving magnet causes current to flow. Magnets are used in electric motors.
11. Induced Magnetism - magnetism caused by touching or being near a magnet.

Title: Maglev Train

Category: Research and Experimentation

Science Concepts:

12. Magnetic Field - an invisible pattern of magnetism around every magnet.
13. Electromagnet - a coil of wire that uses an electric current to make a strong magnetic field. (Electromagnets can be turned off and on). The more turns of the wire the stronger the magnet.
14. Alnico - an alloy of iron, aluminum, nickel, and cobalt which makes extremely strong magnets.
15. Absolute Zero - equivalent to - 460°F or - 273°C (the coldest temperature conceivable) metals that reach this frigid limit lose all their electrical resistance and become superconductors. This enables them to carry currents without any loss of energy and to generate powerful magnetic fields. Now superconductors at higher temperatures are being developed.
16. Ceramics - metallic oxides (compounds of metals and oxygen) used as superconductors.
17. Liquid Nitrogen - used to replace the much more expensive liquid helium. It is used to produce superconductors at 77 Kelvin or -320°F.




A magnet levitates over a superconductor immersed in liquid nitrogen.

Title: Maglev Train

Category: Research and Experimentation

Science Concepts:

Electrical Symbols, Units

| Term | Symbol | Unit |
|---|---|---|
| (EMF) electromotive force | V | Volt |
| electric current | I | ampere |
| resistance | R | ohm |

Ohm's Law - George Ohm found that the electric current in a circuit is affected by the EMF and the resisitance. Ohm's law says that the electric current (I) in a circuit is equal to the EMF (V) divided by the resistance (ohm).

Ohm's law

$$I = \frac{V}{R}$$

Explanation - Maglev Train

Maglevs float above a guideway on a cushion of magnetic force. There is no friction to slow it down. Superconducting electromagnets are built into the sides of each train car. Thousand of metal coils are set into the guideway. The opposing sets of magnets repel each other and lift the train into the air. Rows of electromagnets, on each side of the guideway, repeatedly reverse polarity to move the train.

Advantages - Superconductor Maglevs are energy efficient (cheaper to run). They generate no friction (low repair, maintenance). They are capable of traveling at higher speeds. Safety is another advantage. The underslung suspensions prevent a derailment.

Unlike standard rails, maglev tracks need no heating in winter to melt snow and ice because traction doesn't depend on wheel-to-rail contact.

Title: Maglev Train

Category: Research and Experimentation

Mathematical Concepts:

1. Ohms Law $I = \frac{E}{R}$ of amperes = $\frac{\text{volts}}{\text{ohms}}$

   where:

   I = electric current in amperes

   V = electromatic force in volts

   R = resistance in ohms

   Also variations in formula $E = IR$ and $R = \frac{E}{I}$

2. formula for power ratings $W = EI$ or $P = EI$

   P or W = power in watts

   E = potential in volts

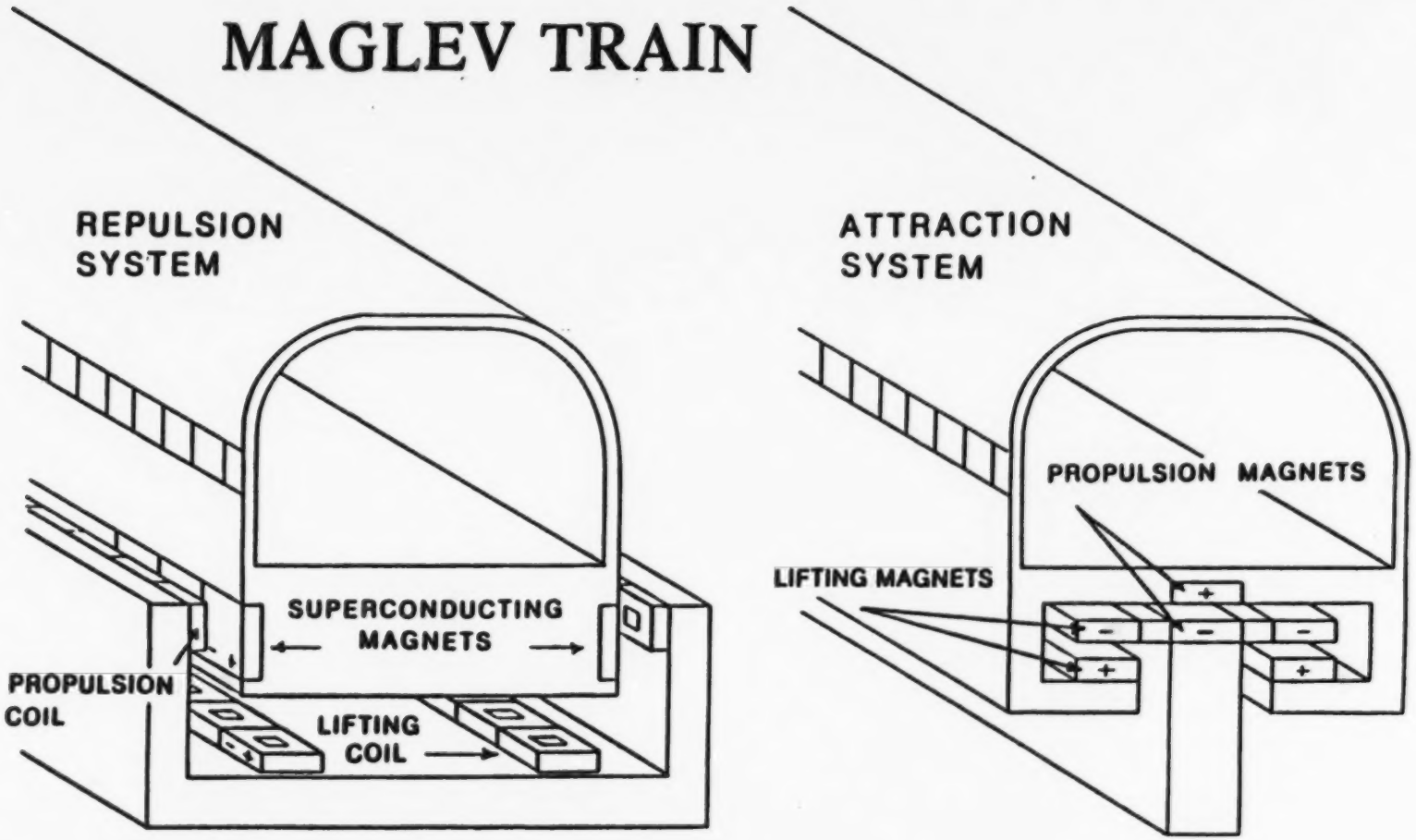
   I = current in amperes

   $W = I^2R$ and $W = \frac{E^2}{R}$

   R = resistance in ohms

3. Understanding of metric measure to construct model and in converting to milliamperes
4. Multiplication and division of decimals
5. Measurement of temperatures
6. Possible conversion of temperatures $C = \frac{5}{9}(F-32)$
7. Concepts of positive and negative nos.

# MAGLEV TRAIN




MEISSNER EFFECT: SUPER CONDUCTORS REPEL MAGNETIC FIELDS (THE MAGNET REMAINS SUSPENDED IN MIDAIR).

$$I = \frac{E}{R}$$

OHM'S LAW: THE CURRENT (I) IN A CIRCUIT IS EQUAL TO THE EMF(E) DIVIDED BY THE RESISTANCE (R).

TITLE: METRIC DRAGSTER

CATEGORY: INNOVATION

DESCRIPTION:

The early motor car was a fragile, termperamental machine, built by men who were discovering design requirements. The dragster is one of such vehicles. It is designed to have very little weight, yet maintain all the features of a race car. The dragster is powered by a $CO_2$ cartridge and travels along a string or wire passing through a hook attached to the bottom of the vehicle.

SCIENCE CONCEPTS:

1. Friction is a force that impedes motion.

2. To reduce friction a lubricant can be applied to moving parts. To reduce friction with the air, the car can be aerodynamically designed.

3. Newton's Laws of Motion:

   (1) an object will remain at rest or continue to move in a straight line at constant velocity unless acted on by a force;
   (2) acceleration of an object increases as the amount of force causing the acceleration increases;
   (3) when a force is exerted on an object, the object exerts an equal force in the opposite direction.

4. A gas has no definite shape or volume; a gas will take the shape of its container; a gas can be compacted rather tightly in a container. This is the case in the $CO_2$ cartridge. When the cartridge is ruptured, the gas escapes rapidly causing movement in the opposite direction.

5. Metric system--a system of measurement based on multiples of ten. The linear units are millimeter, centimeter, meter.

MATHEMATICAL CONCEPTS:

$$\text{Speed} = \frac{\text{Distance}}{\text{Time}}$$

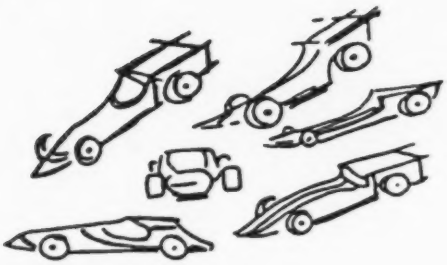
$$\text{Force} = \text{Mass} \times \text{Acceleration}$$

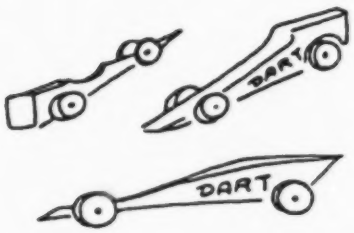
$$\text{Acceleration } a = \frac{v_2 - v_1}{T}$$

$$\text{Ratio of speed to weight} = \frac{\text{Weight (mass)}}{\text{Speed}}$$

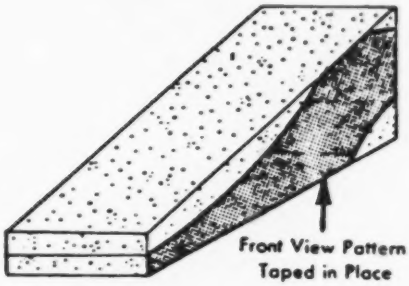
# METRIC DRAGSTER

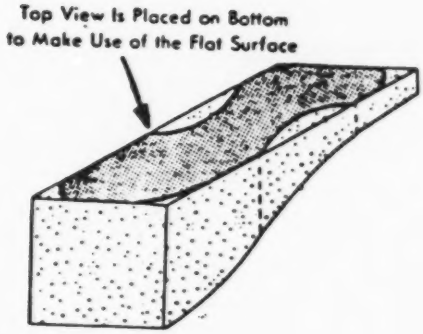
## Creating Alternate Design Solutions

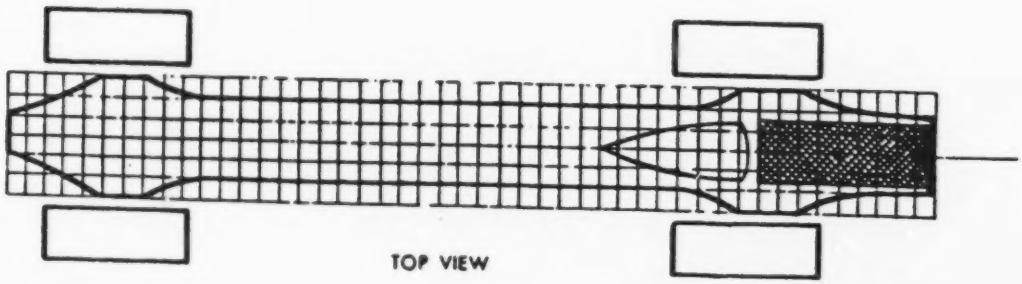


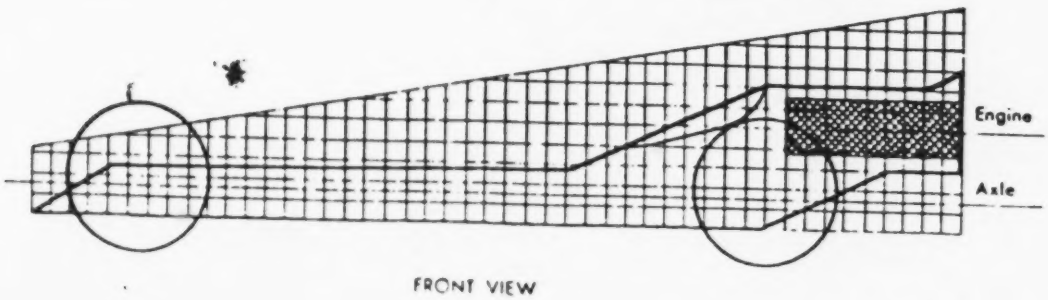



## Making Three-Dimensional Models




BEST COPY AVAILABLE

Title: Operation Sail

Category: Transporation

Description: Operation Sail - a math/science/technology exploration. Using the basic design process, a list of materials and parameters students will research, design, and construct a sailing vessel. Preliminary laboratory stations include testing construction materials for density, buoyancy and solubility. Students predict craft efficiency in light of applicable scientific theories. A grade level regatta tests the product as a culminating activity.

Title: Operation Sail

Category: Transportation

Science Concepts:

1. ARCHIMEDES' PRINCIPLE: The weight of the liquid displaced by a submerged body is equal to the buoyancy force which the liquid exerts on that body.

2. DISPLACEMENT: The weight or volume of a fluid displaced by a floating body i.e. a sailboat hull.

3. BUOYANCY: The tendency or capacity to remain afloat in a liquid or to rise in air or gas.

4. The density of a substance is its mass per unit volume.

5. The density of water at $4^{o}C$ is 0.999973.

6. Objects which are less dense than water float in water due to the upward force exerted by the water.

7. The hydrometer can be used to determine liquid densities.

8. Visconsity is the degree to which a fluid resists flow under applied force.

9. SURFACE TENSION - Water behaves like a stretched elastic membrane. A needle will lie at rest in a shallow depression caused by its weight as if it were on a rubber air cushion.

10. FRICTION - the force that opposes motion.

11. Mechanical energy is required to overcome friction.

12. Solubility - the property or quality of entering into solution. The solubility of materials used in construction is to be determined.

13. KINETIC ENERGY: Energy of motion. The ability of moving objects or matter to do work. Kinetic energy is available as a result of harnessing a natural source - in this case - wind.

14. WIND: All winds are caused by three natural events. Those events are the rotation of the earth, unequal heating of the oceans and land, and differences in temperature of the atmosphere. Heated air expands, grows lighter, and rises. Cooler air rushes in to replace it.

Title: Operation Sail

Category: Transportation

Math Concepts

1. $d = m/V$ Density = mass ÷ volume

2. $W = F \times d$ Work (joules) = force (newtons) x distance (meters)

   Work is measured in foot-pounds for conventional U.S. measure. A foot-pound is the amount of force necessary to move a 1 lb. load a distance of one foot.

3. $P = W/t$ or $P = \frac{d \times F}{t}$ Power = work ÷ time; Power = $\frac{\text{distance x force}}{\text{time}}$

   Power is the amount of work done in a given amount of time.

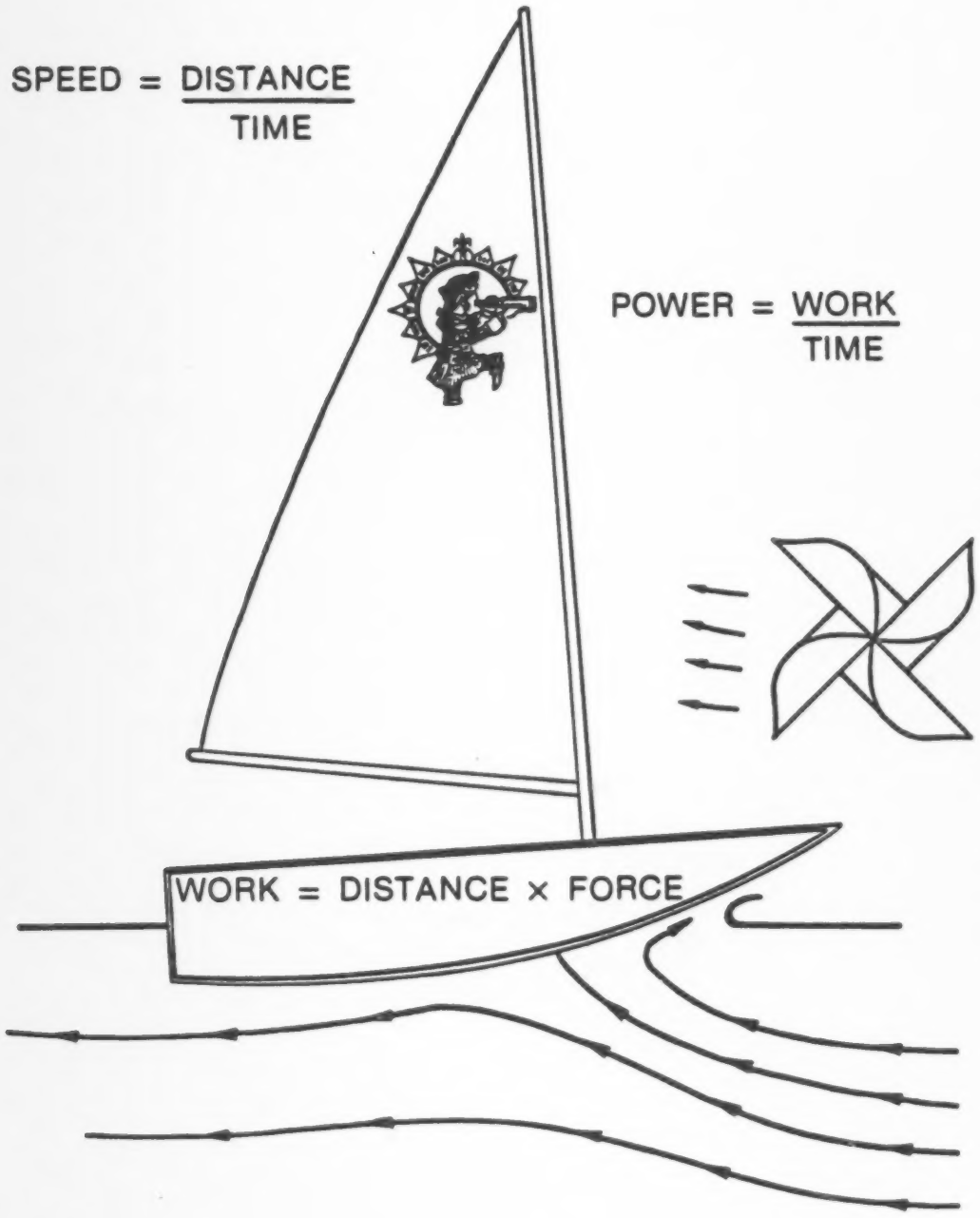
4. $S = d/t$ Speed = distance ÷ time

5. Measurement in metrics

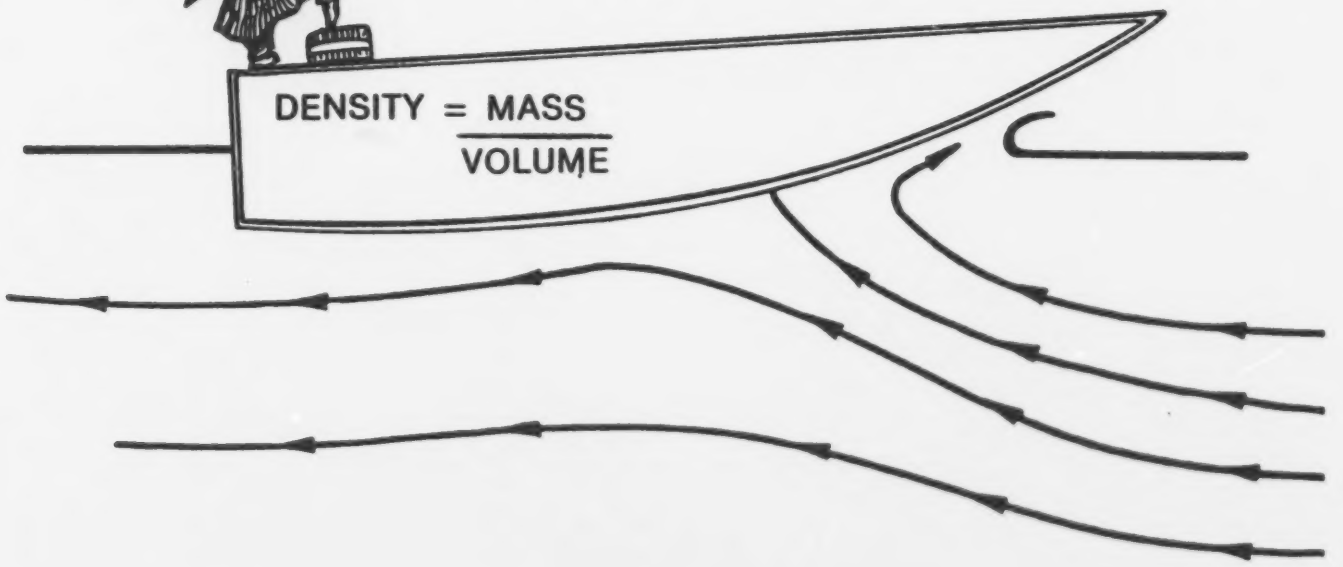
6. Multiplication of fractions and decimals

7. Division of fractions and decimals

# OPERATION SAIL



# OPERATION SAIL



Title: Reaction Engine Car

Category: Research and Experimentation

Description:

A reaction engine is a heat engine in which the expansion of a combustion product is forcibly exhausted, producing an equal but opposite force on the vehicle in which the engine is mounted. It is the type of engine used in rockets. This particular "CAR" is a model of the reaction engine. It will be used to demonstrate the basic principles of motion used by this type of engine; particularly, Newton's Third Law of motion - action and reaction are equal and opposite. The air being forced out of the balloon will represent the action while the car moving represents the reaction. This same effect is produced in rocket engines. Also, included are some variables including wheel size, inflation and angle of inclination. The effects of these changes will be examined.

Title: Reaction Engine Car

Category: Research and Experimentation

Science Concepts:

1. Newton's Law of Gravitation: Every object in the universe attracts every other object with a force that is proportional to the product of their masses and inversely proportional to the square of the distance between them.

2. Newton's Laws of Motion:

   I. An object at rest remains at rest and an object in motion remains in motion at a constant speed and in a straight line unless acted upon by an unbalanced force.

   II. For a given mass, the greater the force applied, the greater the acceleration produced. For a given force, the greater the mass of the object, the less acceleration produced.

   III. For every action, there is an equal and opposite reaction.

3. Reaction Engine: A heat engine in which the expansion of combustion products is forcibly exhausted, producing an equal but opposite force on the engine and the vehicle.

4. Balanced Forces: Are equal but opposite in direction - therefore, produce no change in motion.

5. Inertia: Tendancy to remain at rest or to continue in a straight line and constant speed unless acted upon by an unbalanced force.

6. Velocity: Speed and direction

Title: Reaction Engine Car

Category: Research and Experimentation

Science Concepts:

7. Acceleration: Rate of change in motion.
8. Mass: Amount of matter.
9. Weight: Force of gravity acting upon mass.
10. Deceleration: Negative acceleration.
11. The atmosphere has weight and exerts pressure
12. The pressure of moving air is greater than the normal pressure in the direction in which the air is moving.
13. Pressure: Total force on a surface divided by the area of the surface.
14. Volume: Amount of space occupied by matter.
15. Density: Mass per unit volume.
16. Potential Energy: Energy of position of condition.
17. Kinetic Energy: Energy of motion
18. Friction: Force of resistance
    - A. Wheels-Track
    - B. Axel-Wheels
    - C. Straw-String
    - D. Vehicle-Air
19. Thrust: A force that propels an air or spacecraft along its line of flight.

Title: Reaction Engine Car

Category: Research and Experimentation

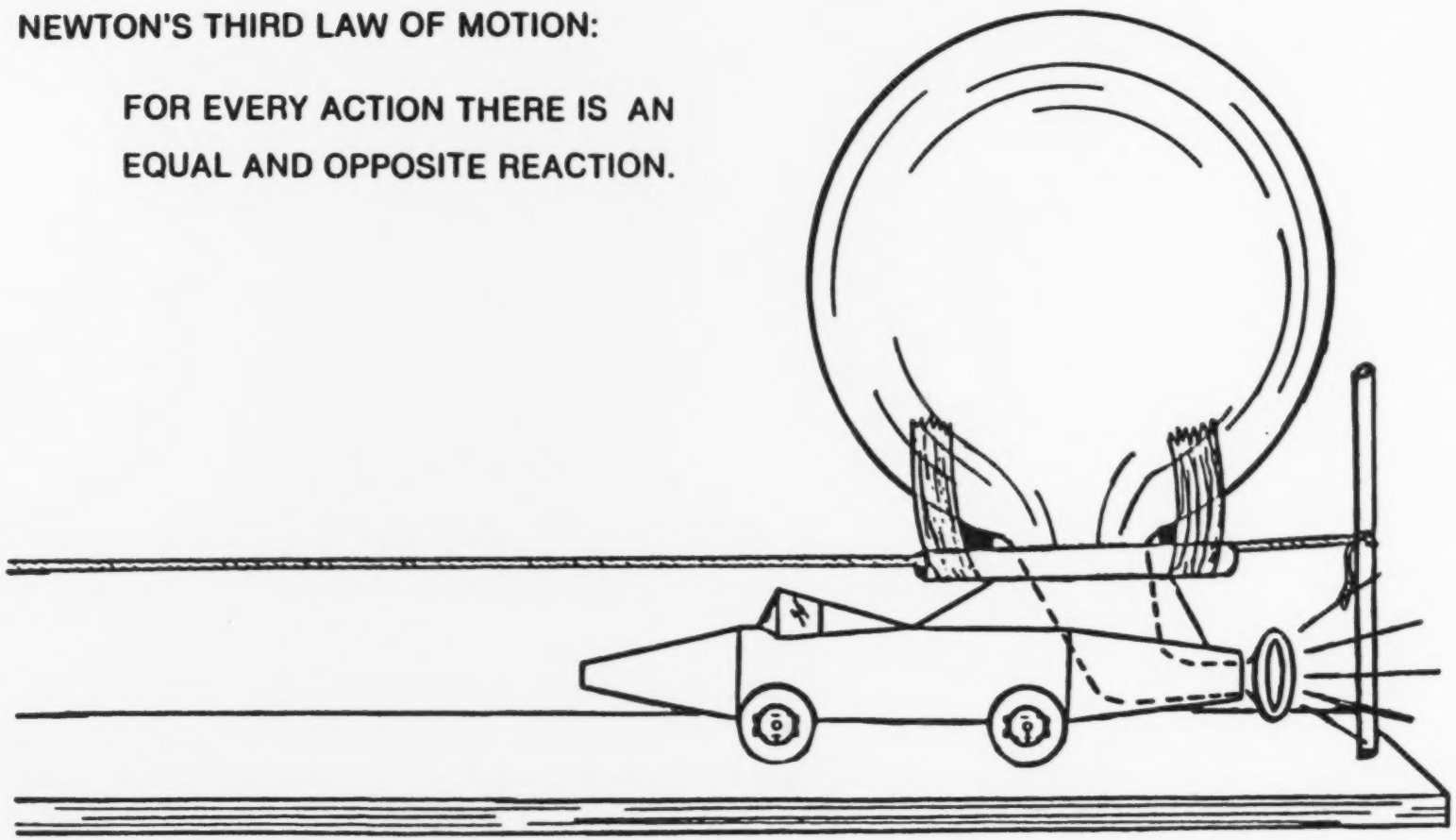
Math Concepts:

1. $F = ma$ — Force = Mass x Acceleration
2. $a = v/t$ — Acceleration = Velocity/Time
3. Substituting: $F = m\ (v/t)$
4. $P = F/a$ — Pressure = force/area
5. $KE = 1/2\ MV^2$ — Kinetic Energy = 1/2 Mass x Velocity $^2$
6. $R = d/t$ — Rate (speed) = Distance/Time
7. $M = mv$ — Momentum = Mass x Velocity
8. $V = \pi d^3/6$ — Volume of Sphere = pi /6 x diameter $^3$
9. $SA = \pi d^2$ — Surface area of sphere = pi x diameter $^2$
10. $C = \pi d$ — Circumference = pi x Diameter
11. Solving Proportions
    - A. Pressure and volume inversely proportional
    - B. Volume and density inversely proportional
    - C. Pressure and density proportion
    - D. Newton's Law of Gravitation
12. Simplifying ratios
13. Multiplying/dividing decimals and fractions

# REACTION ENGINE CAR

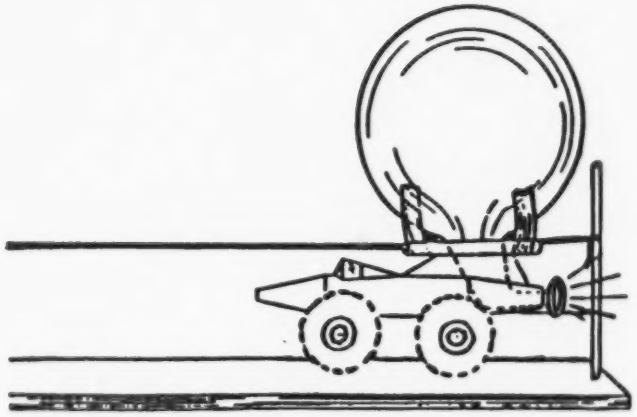
**NEWTON'S THIRD LAW OF MOTION:**

**FOR EVERY ACTION THERE IS AN EQUAL AND OPPOSITE REACTION.**

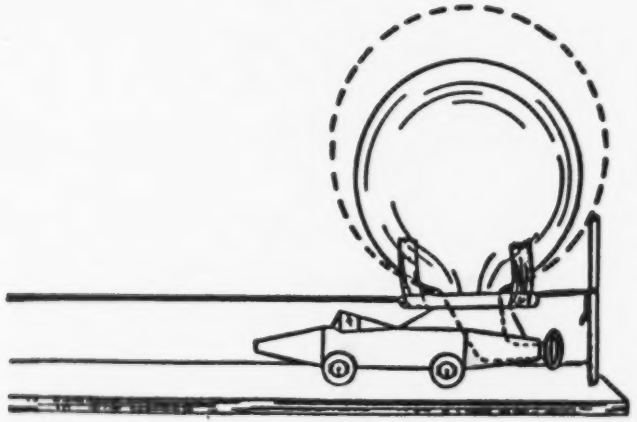


# REACTION ENGINE CAR

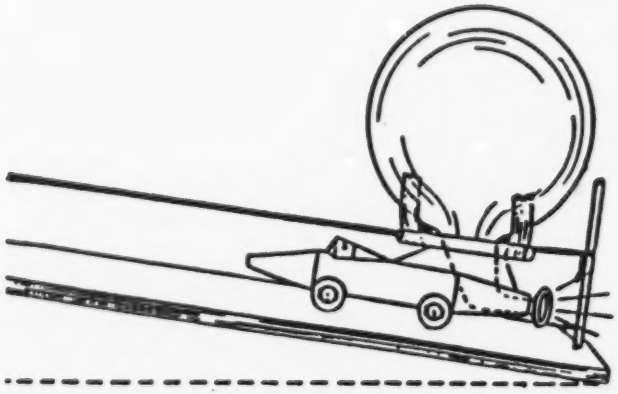
## VARIATIONS



WHEEL SIZE



INFLATION



ANGLE OF INCLINATION

TITLE: WRIGHT BROTHERS AIRPLANE

CATEGORY: INNOVATION

DESCRIPTION:

The Wright's plane 'Flyer 1,' was a bi-plane with an airframe built of spruce and covered with unbleached muslin. It had twin 'pusher' propellers, front elevators and rear rudders. The first successful flight in this craft lasted 12 seconds.

SCIENCE CONCEPTS:

1. Simple machine--a device that helps you do work by increasing force, increasing speed, or changing the direction of the force.

   Wheel and axle--a simple machine that is a type of lever.

   Lever and fulcrum--a bar or board that is free to pivot about a fixed point.

   Gears--a kind of wheel-like machine that acts like a lever.

   Pulley--a lever that rotates around a fixed point.

2. Friction is a force that acts to slow down a moving object that is passing through or against a material. A force is a push or pull.

3. Heat engines use heat energy to do work.

4. Heat engines operate on the principle that when a gas is heated its pressure increases.

5. Boyle's Gas Law states the volume of a gas varies inversely with the pressure applied to it, provided the temperature remains constant.

6. Charles' Gas Law states the volume of a gas varies directly with the temperature applied to it, provided the pressure remains constant.

7. Heat losses prevent heat engines from being perfectly efficient.

8. The four basic strokes of an internal combustion engine are intake, compression, power, and exhaust.

9. Energy is needed for work to be done.

10. Work is the result of a force acting on a body and moving it through a distance.

11. Energy conversion occurs as energy is transferred from chemical to mechanical.

SCIENCE CONCEPTS:

(CONTINUED)

12. Newton's First Law of Motion states that a body at rest will remain at rest unless it is acted upon by an outside force. A body in motion will continue moving in a straight line at a uniform speed unless acted upon by an outside force.

13. Newton's Second Law of Motion states that a force proportional to the rate of change of the velocity is produced whenever a body (mass) is accelerated.

14. Newton's Third Law of Motion states that to every action, there is always an equal and opposite reaction.

15. Thrust is a forward push or force produced by a jet or rocket engine. Thrust is measured in pounds.

MATHEMATICAL CONCEPTS:

1. Use of formulas ··

   a) $\text{Power} = \frac{F \times D}{T} \longrightarrow \frac{\text{Force} \times \text{Distance}}{\text{Time}}$

   b) $1 \text{ hp} = \frac{550 \text{ ft./lbs.}}{\text{sec.}}$

   c) $\text{Horsepower} = \frac{F \times V}{33{,}000} \longrightarrow \frac{\text{Force} \times \text{Velocity}}{33{,}000}$

   d) $\text{Horsepower} = \frac{F \times D}{T \times 550} \longrightarrow \frac{\text{Force} \times \text{Distance}}{\text{Time (sec.)} \times 550}$

   e) $\text{Force} = P \times A \longrightarrow \text{Pressure} \times \text{Area}$

   f) $\text{Pressure} = \frac{\text{Force (wt)}}{\text{Area}}$

   g) $\text{Area} = \pi r^2$

   h) Work = Weight x Distance

   i) $\text{M.A.} = \frac{\text{Load}}{\text{Effort}}$

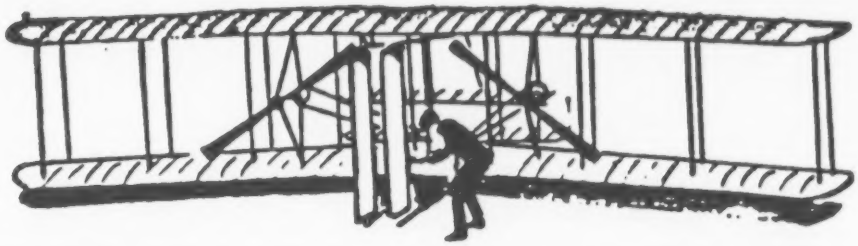
2. Solving equations with variables.

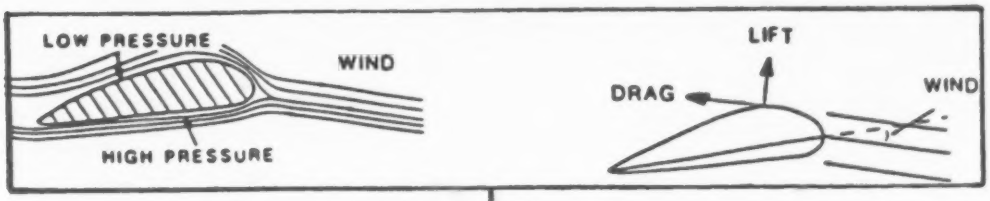
3. Mathematical operations.

4. Exponents.

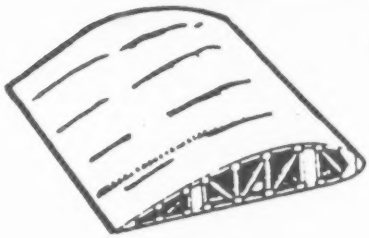
5. Rational numbers.

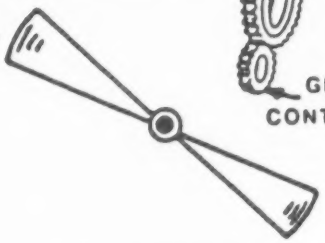
# WRIGHT BROTHERS AIRPLANE






BERNOULLI'S PRINCIPLE





GEARS
CONTROL MOTION

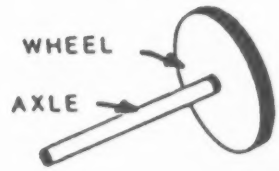
LIFT

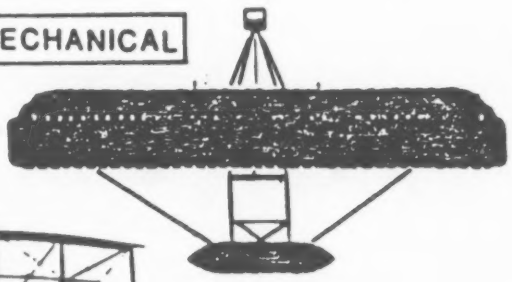
THRUST

INTERNAL COMBUSTION ENGINE

ENERGY CONVERSION

CHEMICAL → MECHANICAL





DISTANCE

VELOCITY x TIME